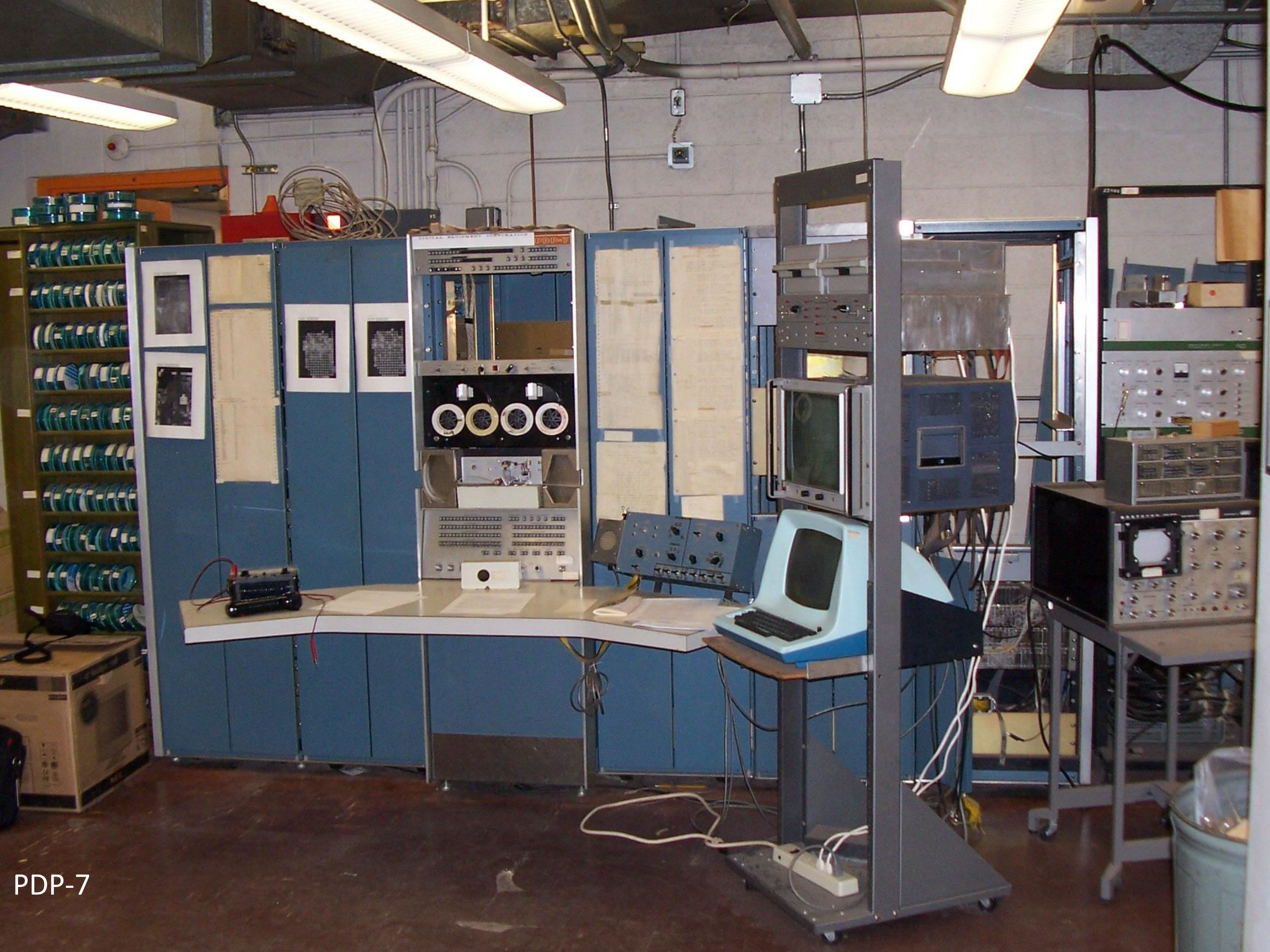
CIS colloquium presented by Harlan Lefevre on Thursday, January 13

The University's 40 year old PDP-7 computer is alive again in Seattle

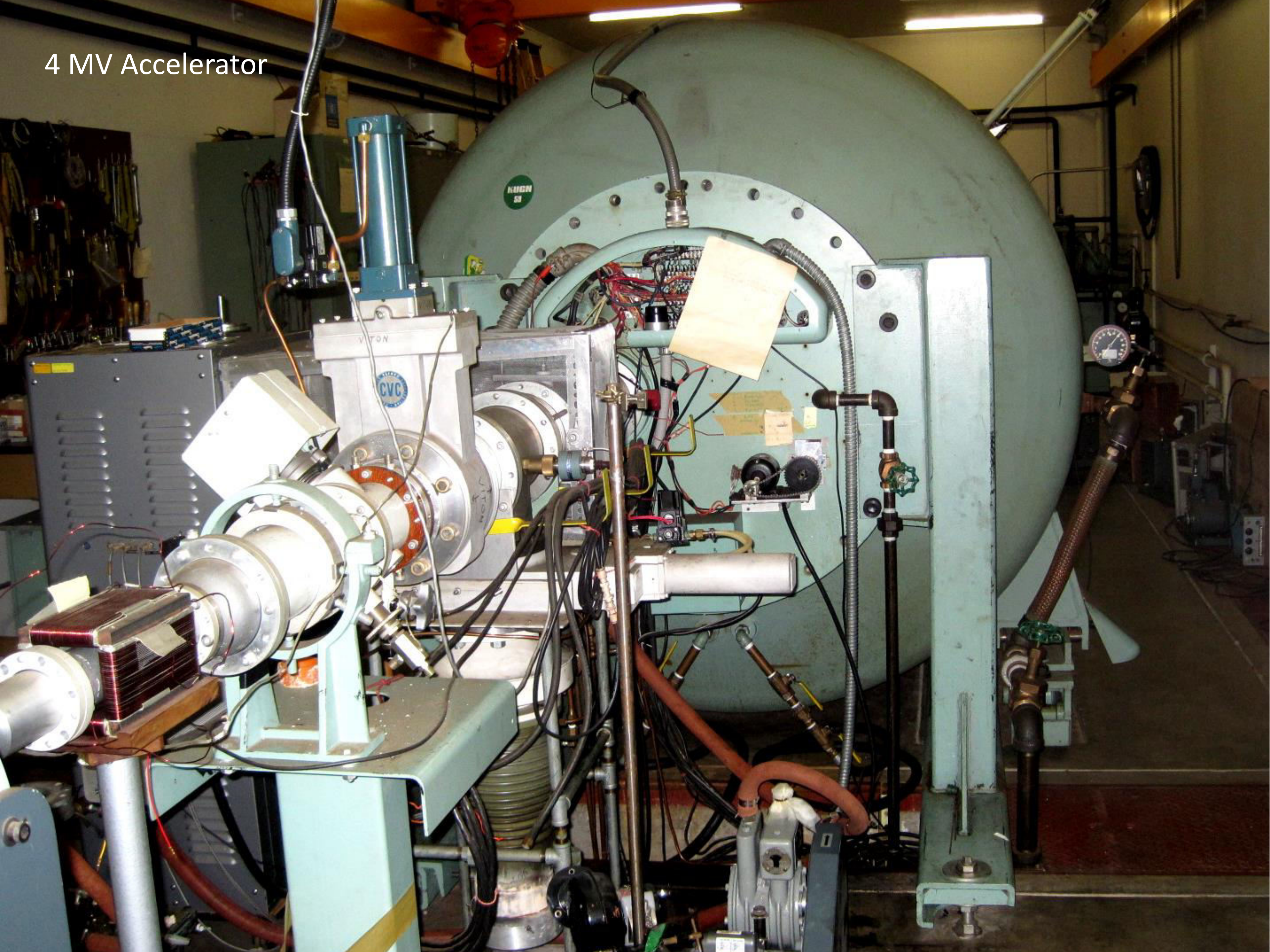
Harlan W. Lefevre, Emeritus Professor of Physics, University of Oregon

In January 2006 I sent an e-mail to Paul Allen's website (PDPplanet.com) describing our Digital Equipment Corporation PDP-7 computer. I suggested that this computer, the last PDP-7 in operation in the world, should have a museum home. The PDPplanet people immediately came to see the machine and stated that they would keep it in operation if it came to their "Living Computer Museum". I will describe the two year bureaucratic struggle it took to transfer the computer to the museum. I'll then go back to the beginning: How did we acquire this remarkable computer, learn how to use it in nuclear spectroscopy, and have fun along the way.



PDP-7

4 MV Accelerator



How did we get the PDP-7?

Our accelerator proposal had been funded by AEC in early 1964. Centers of Excellence proposal to NSF later in 1965 brought in about $5million. That grant included an IBM 360-50 and the PDP-7 with a link between them to be provided by DEC. The PDP-7 was a dedicated computer for nuclear physics.

The PDP-7 was installed in the basement of the Volcanology Building in Feb. 1966 with the 360-50 computer on the first floor.

After the 360 moved to the new Computing Center, a bundle of 50 coaxial cables was Installed in the heating tunnel between Volcanology and the Computing Center a quarter mile away to maintain the link. They are still there. The link was not heavily used.

What did we use the PDP-7 for?

Nuclear spectroscopy – sorting and counting events from detectors according to pulse height, pulse shape or time of occurrence and storing and displaying the results. It was also used for controlling experiments.

E-mail to PDPPlanet.com, January 24, 2006

PDP-7 at the University of Oregon in Eugene

Last week William Maddox visited our laboratory in the Physics Department to see our PDP-7 computer. He suggested that ours is the last running PDP-7 in the world and that it's existence should be reported to PDP-planet.com.

The PDP-7 arrived in Eugene almost exactly 40 years ago. It came with an 8k core memory. Two years later a second bank of 8k was added. Many interfaces to laboratory equipment were added over the years, and these were useful enough and reliable enough that we kept the computer in operation. It's hour meter indicates 60,000 plus hours.

It is not clear how much longer the PDP-7 can be kept in operation. I am the only one left here that is inclined to keep it going. As an Emeritus Professor at age 76, eight years retired, I am loosing or have lost my clout and may loose the space to other University needs. I hope that the machine may soon find a museum home. I am interested in comments from this forum.

PDP7 Finds a Home!

Microsoft's Paul Allen allows the venerable UO computer to retire in glory

In mid-June, one of the UO's historic workhorse computers, a DEC PDP7 employed for more than 30 years in analyzing neutron physics data and in Federal Aviation Administration safety studies[1], was relocated to the state of Washington.

The PDP7 was rescued from oblivion by PDPplanet.com, a resource for computer history organized by Microsoft cofounder Paul Allen. PDPplanet is dedicated to enshrining Allen's growing collection of Digital Equipment Corporation mainframes and minicomputers.

Photos and histories of these computers, many of which are being restored to full working order, are available on PDPplanet's website at **http://www.pdpplanet.com/**

In an archive photo, physics professor Harlan Lefevre puts the still-functioning PDP7 through its paces in the Volcanology basement. Both Prof. Lefevre and the PDP7 are now retired.

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[1] See "Goodbye to the PDP7" in the Fall 2001 issue of *Computing News* (**http://cc.uoregon.edu/cnews/fall2001/pdp7.html**)

Architectural Evolution in DEC's 18b Computers

Bob Supnik, revised 16-Jun-2006

Abstract

DEC built five 18b computer systems: the PDP-1, PDP-4, PDP-7, PDP-9, and PDP-15. This paper documents the architectural changes that occurred over the lifetime of the 18b systems and analyses the benefits and tradeoffs of the changes made.

Introduction

From 1961 to 1975, Digital Equipment Corporation (DEC) built five 18b computer systems: the PDP-1, PDP-4, PDP-7, PDP-9, and PDP-15 (see table below). Each system differed from its predecessors, sometimes in major ways representing significant architectural breaks, and sometimes in minor ways representing new features or incompatibilities. The architectural evolution of these systems demonstrates how DEC's ideas about architectural versus implementation complexity, I/O structures, and system features evolved over the period of a decade.

	PDP-1	PDP-4	PDP-7	PDP-9	PDP-15
First ship	Nov 1960	Jul 1962	Dec 1964	Aug 1966	May 1970
Number built	50	45	120	445	790
Memory cycle	5usec	8usec	1.75usec	1usec	0.8usec
Base price	$120K	$65.5K	$45K	$25K	$19.8K

Reproduced from Computer Engineering: A DEC View Of Hardware Systems Design

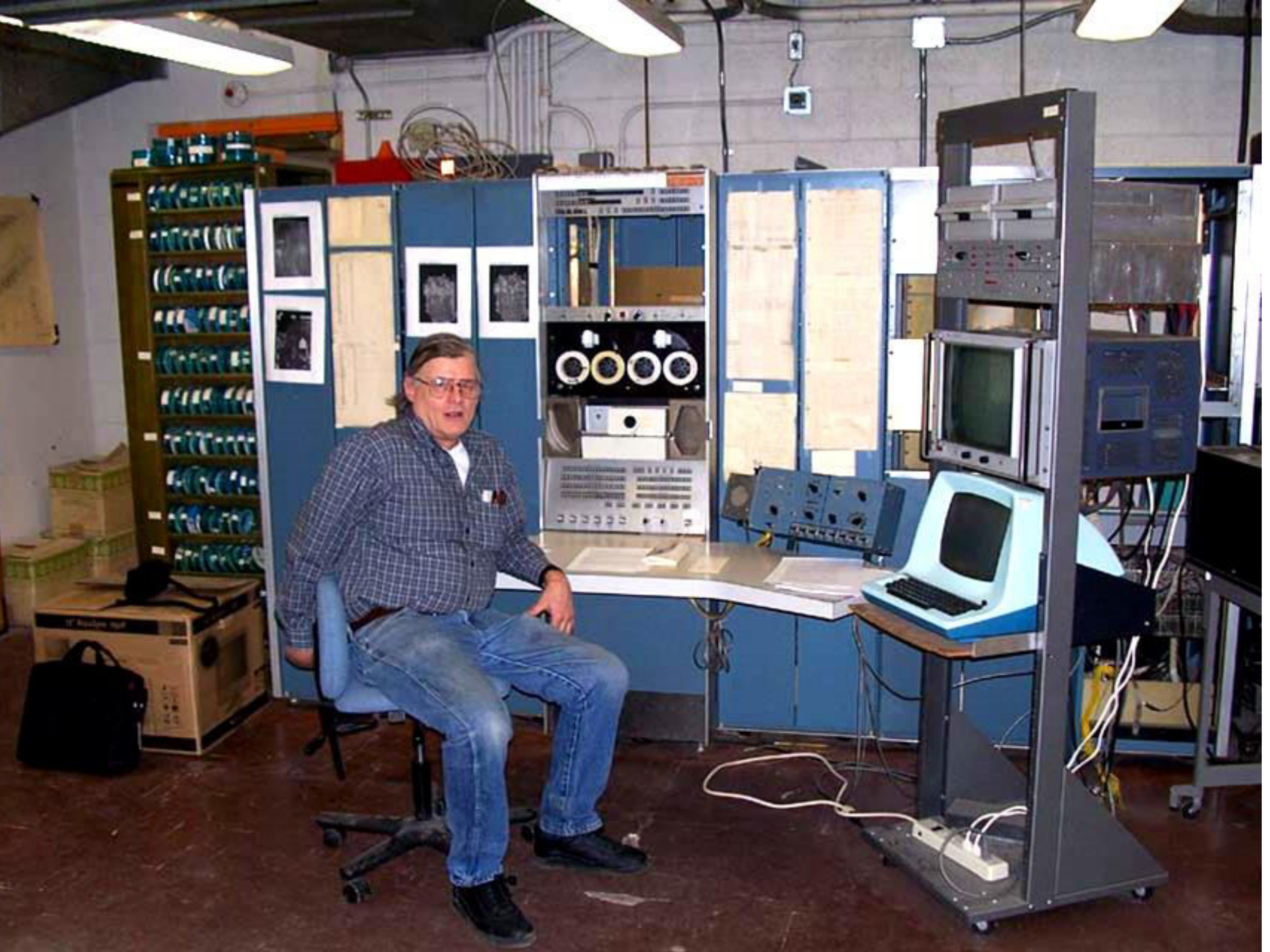
After many unsuccessful years of searching, a copy of DECsys was found with the last functioning PDP-7 on the planet, Professor Harlan Lefevre's system at the University of Oregon (soon to reside at Paul Allen's PDP Planet in Seattle). But so far, no copies have been found of an even more historic system for the PDP-7, UNIX. The PDP-7's multi-user protection, crude as it was, sufficed for implementation of the first version of UNIX, making the PDP-7 a significant system in the history of computing. Unfortunately, all copies of UNIX for the PDP-7 have been lost. Some details of the PDP-7 version can be found on Dennis Ritchie's personal web site.

Most recently, Professor Harlan Lefevre of the University of Oregon made an invaluable contribution to the software archive for the 18b PDP's by providing a copy of DECsys, DEC's first mass storage operating system. Professor Lefevre's careful preservation of a functioning PDP-7 and all its software made possible the restoration of a long-missing piece of DEC history.

Seattle, June 10, 2010, 2:03PM

Keith Perez - (movie file)

Please view the movie file at –
http://www.soemtron.org/downloads/decinfo/pdp7lives.mpeg



Construction technique

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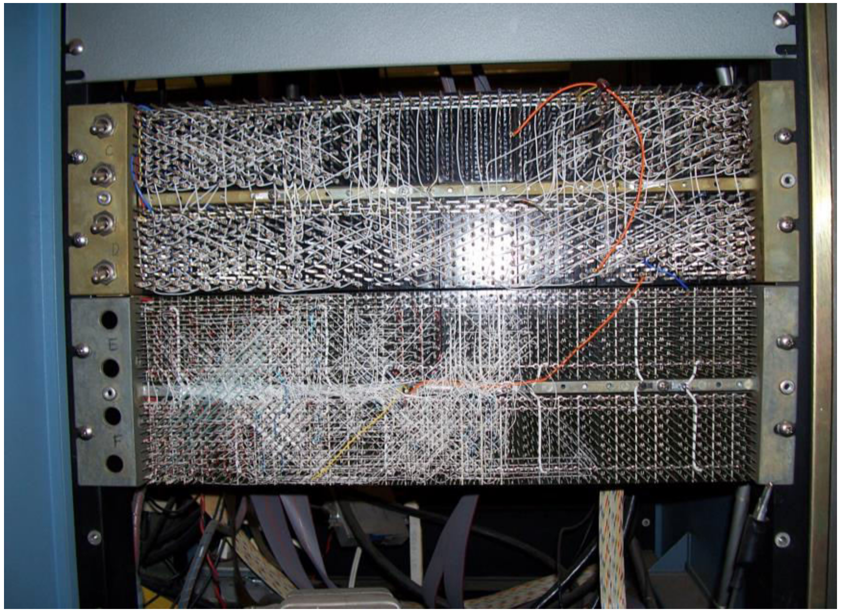
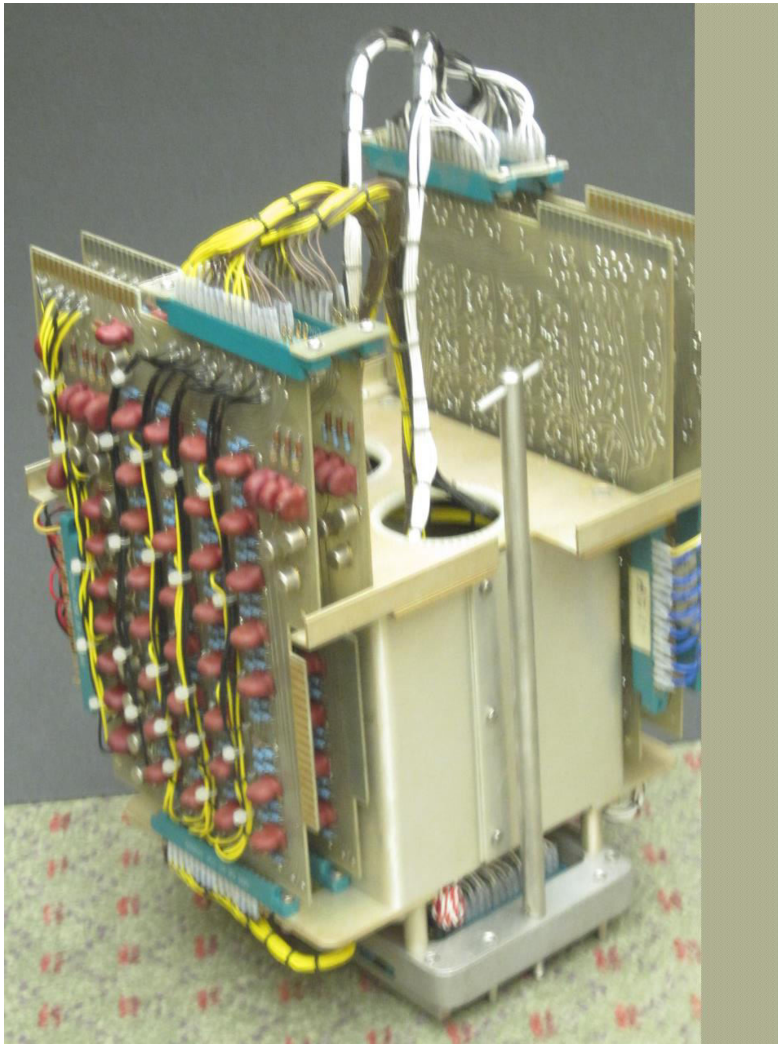




Magnetic core memory

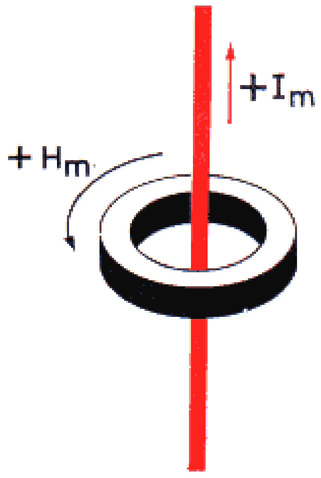


Fig. 5a

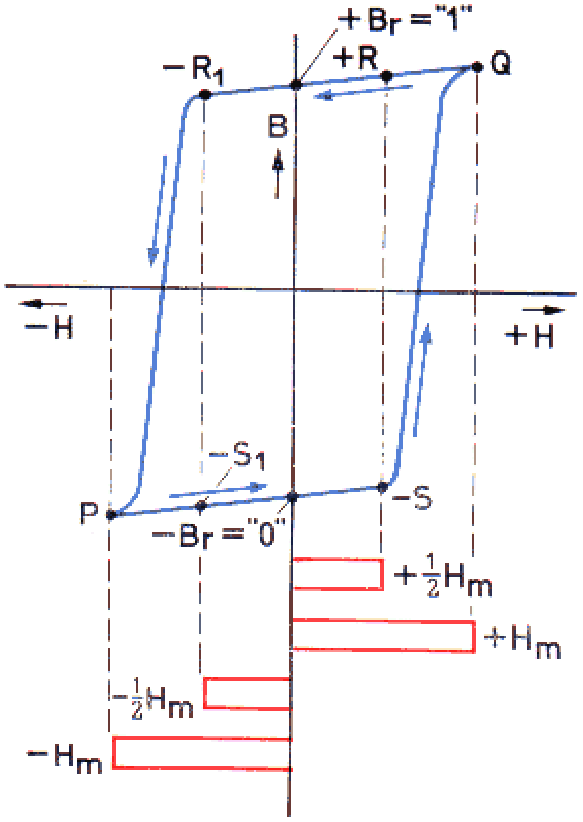
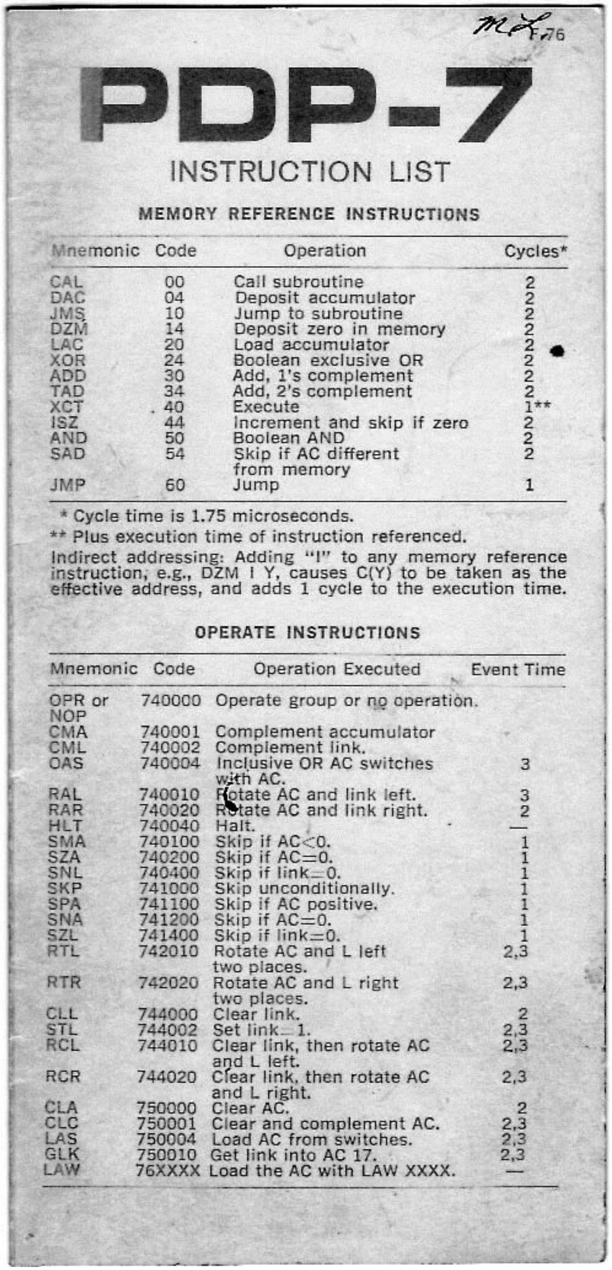


Fig. 5b

The instruction set.

Memory reference, operate, Input/Output and all that.

Beginners can’t carry on a conversation until they know something about the instruction set.



mL F.76

PDP-7

INSTRUCTION LIST

MEMORY REFERENCE INSTRUCTIONS

Mnemonic	Code	Operation	Cycles*
CAL	00	Call subroutine	2
DAC	04	Deposit accumulator	2
JMS	10	Jump to subroutine	2
DZM	14	Deposit zero in memory	2
LAC	20	Load accumulator	2
XOR	24	Boolean exclusive OR	2
ADD	30	Add, 1's complement	2
TAD	34	Add, 2's complement	2
XCT	40	Execute	1**
ISZ	44	Increment and skip if zero	2
AND	50	Boolean AND	2
SAD	54	Skip if AC different from memory	2
JMP	60	Jump	1

* Cycle time is 1.75 microseconds.

** Plus execution time of instruction referenced.

Indirect addressing: Adding “I” to any memory reference instruction, e.g., DZM I Y, causes C(Y) to be taken as the effective address, and adds 1 cycle to the execution time.

OPERATE INSTRUCTIONS

Mnemonic	Code	Operation Executed	Event Time
OPR or NOP	740000	Operate group or no operation.	
CMA	740001	Complement accumulator	
CML	740002	Complement link.	
OAS	740004	Inclusive OR AC switches with AC.	3
RAL	740010	Rotate AC and link left.	3
RAR	740020	Rotate AC and link right.	2
HLT	740040	Halt.	—
SMA	740100	Skip if AC<0.	1
SZA	740200	Skip if AC=0.	1
SNL	740400	Skip if link=0.	1
SKP	741000	Skip unconditionally.	1
SPA	741100	Skip if AC positive.	1
SNA	741200	Skip if AC=0.	1
SZL	741400	Skip if link=0.	1
RTL	742010	Rotate AC and L left two places.	2,3
RTR	742020	Rotate AC and L right two places.	2,3
CLL	744000	Clear link.	2
STL	744002	Set link=1.	2,3
RCL	744010	Clear link, then rotate AC and L left.	2,3
RCR	744020	Clear link, then rotate AC and L right.	2,3
CLA	750000	Clear AC.	2
CLC	750001	Clear and complement AC.	2,3
LAS	750004	Load AC from switches.	2,3
GLK	750010	Get link into AC 17.	2,3
LAW	76XXXX	Load the AC with LAW XXXX.	—

From DECUS-SCOPE, 1968

C. A. Burke and H. W. Lefevre
Physics Department
University of Oregon
Eugene , ***Oregon***

The following subroutine for generating a logarithm and scaling it for a ten-bit display results from a comment by Professor Robert Borchers of the University of Wisconsin.

> ***“The obvious way to make a fast logarithmic display is make it linear between binades.”***

LOGCAL is written for a PDP-7 with extended arithmetic. It 'generates a characteristic by finding the most significant bit and tacking on the six next most significant bits for use in lieu of a true mantissa. As listed below the routine plots numbers, 2^2 or less on the base line and plots 2^18 -1 at full scale on a ten bit display. The maximum deviation from the true logarithm is less than 1 % of full scale with sixteen binades on scale. There is, of course, no error for any number with a zero mantissa. The subroutine is entered with the number to be converted in the accumulator and returns with the logarithm properly scaled for an immediate DYL.

```
LOGCAL,          0
                 SPA!CLL
                 JMP .+11
           CLQ! NORM-25
                 RTL
                 LMQ
                 LACS
                 SNA!CMA
                 SKP!CLA
                 LLS 6
                 JMP I LOGCAL
                 LRS 13
                TAD (I600
                JMP I LOGCAL
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Ed Ross

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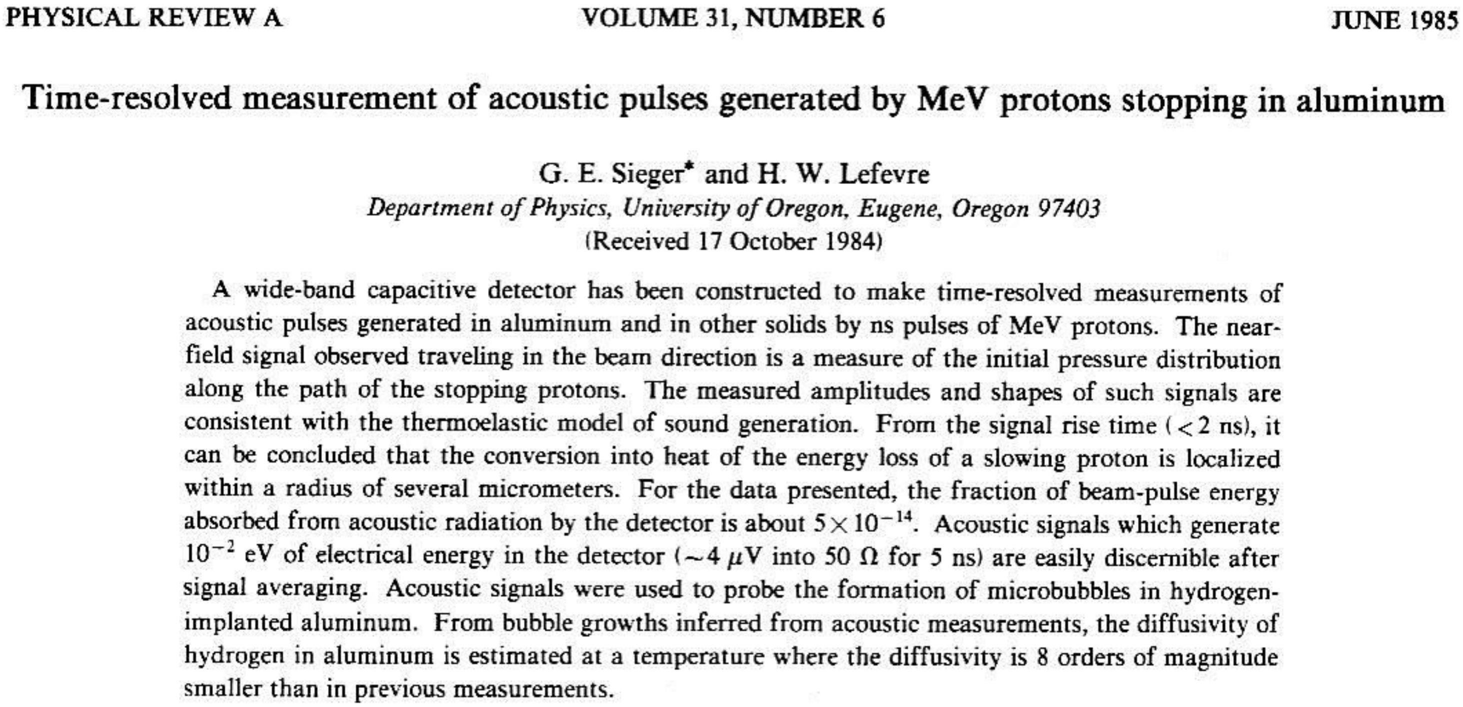

PHYSICAL REVIEW A VOLUME 31, NUMBER 6 JUNE 1985

Time-resolved measurement of acoustic pulses generated by MeV protons stopping in aluminum

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Department of Physics, University of Oregon, Eugene, Oregon 97403

(Received 17 October 1984)

A wide-band capacitive detector has been constructed to make time-resolved measurements of acoustic pulses generated in aluminum and in other solids by ns pulses of MeV protons. The near-field signal observed traveling in the beam direction is a measure of the initial pressure distribution along the path of the stopping protons. The measured amplitudes and shapes of such signals are consistent with the thermoelastic model of sound generation. From the signal rise time (<2 ns), it can be concluded that the conversion into heat of the energy loss of a slowing proton is localized within a radius of several micrometers. For the data presented, the fraction of beam-pulse energy absorbed from acoustic radiation by the detector is about 5×10^{-14}. Acoustic signals which generate 10^{-2} eV of electrical energy in the detector ($\sim4\ \mu$V into 50 Ω for 5 ns) are easily discernible after signal averaging. Acoustic signals were used to probe the formation of microbubbles in hydrogen-implanted aluminum. From bubble growths inferred from acoustic measurements, the diffusivity of hydrogen in aluminum is estimated at a temperature where the diffusivity is 8 orders of magnitude smaller than in previous measurements.

Greg Sieger

Acoustic pulses

preamp

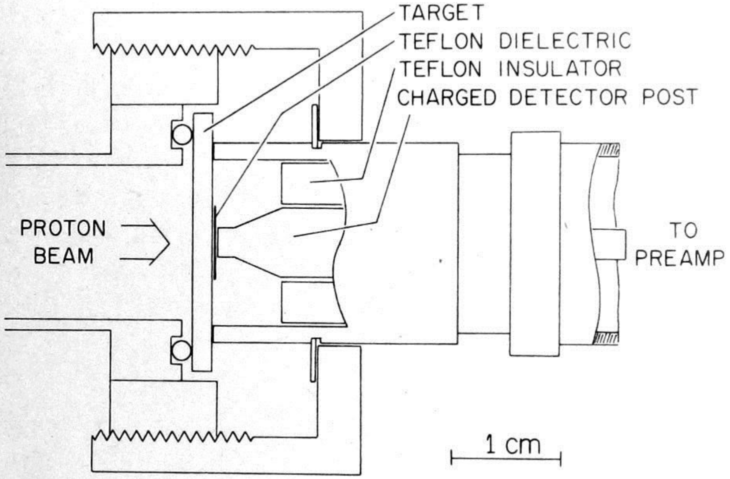


FIG. 1. Schematic drawing of the capacitive detector, shown mounted on the end of the beam line.

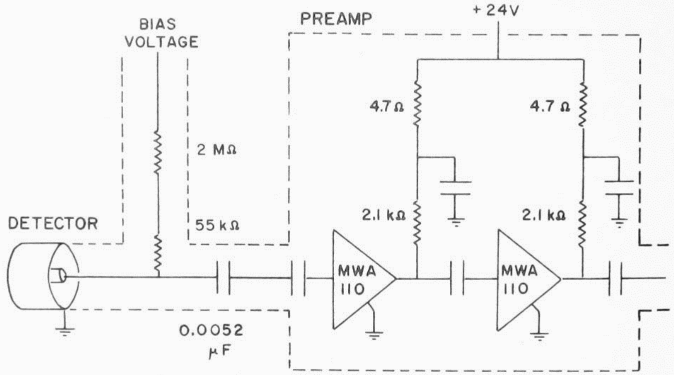


FIG. 2. Schematic drawing of detector and preamplifier circuit. All capacitors in the preamp are 0.1 μF ceramic chip capacitors.

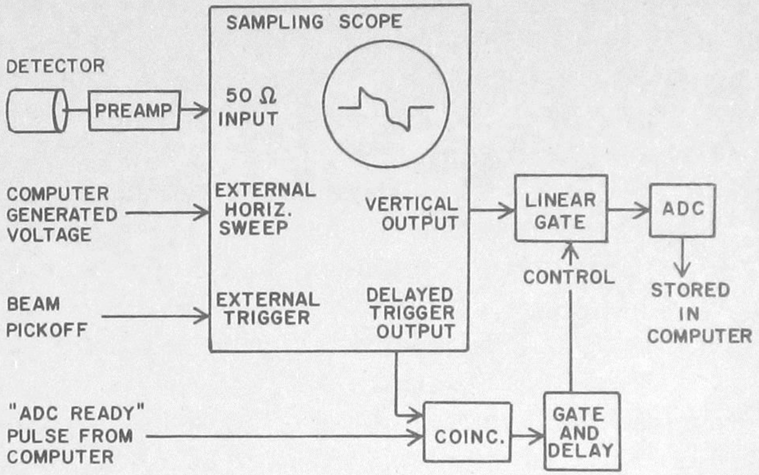


FIG. 3. Simplified block diagram of the electronics used to sample, digitize, and record acoustic signals.

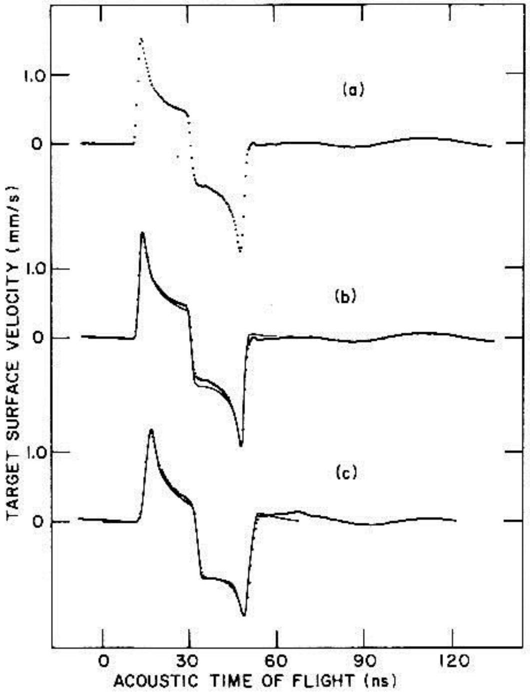


FIG. 4. (a) Acoustic signal generated by a 3.74-MeV proton beam stopping in aluminum. The origin on the abscissa is arbitrary. (b) Same signal as in (a), together with a calculated waveform. (c) Reflected acoustic signal which arrives at the detector about 400 ns after the signal in (a), together with a calculated waveform. The origin on the abscissa is arbitrary.

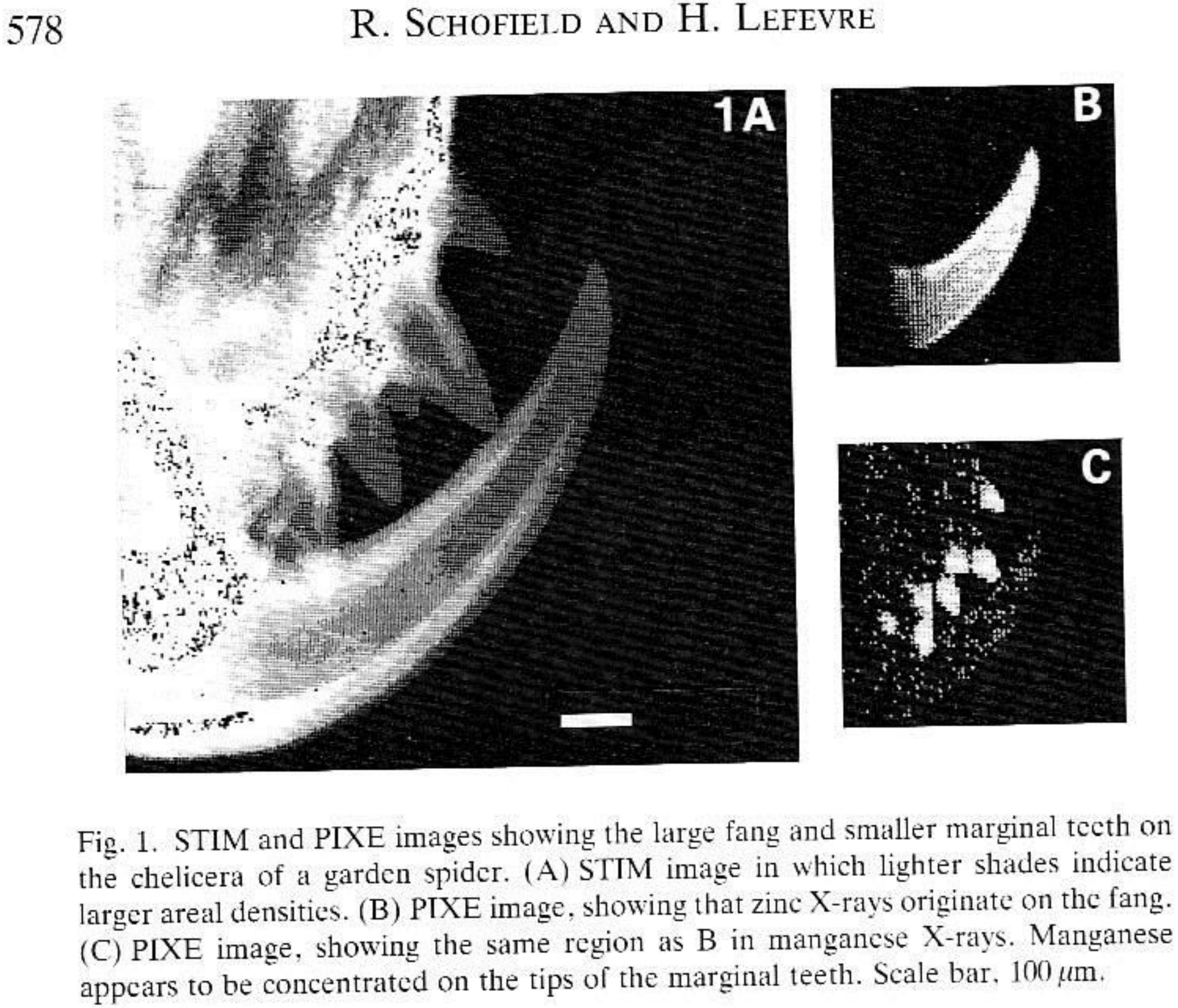
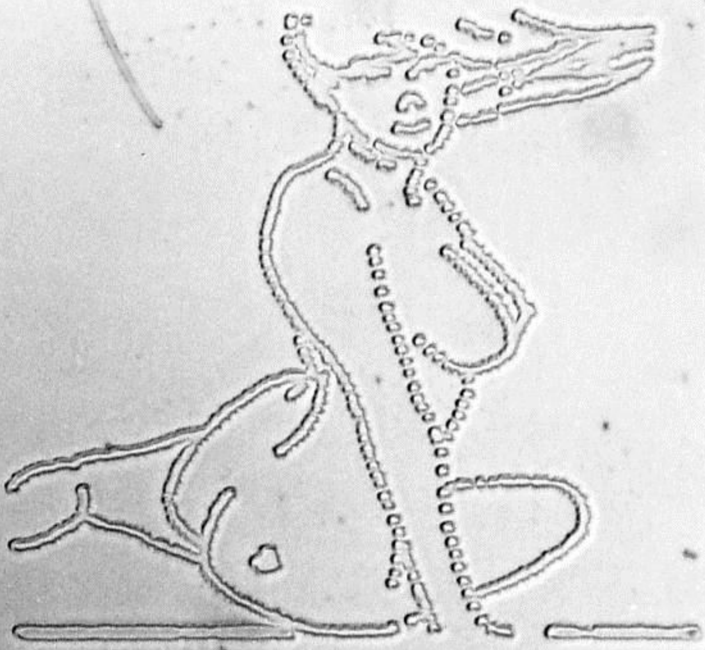


Fig. 1. STIM and PIXE images showing the large fang and smaller marginal teeth on the chelicera of a garden spider. (A) STIM image in which lighter shades indicate larger areal densities. (B) PIXE image, showing that zinc X-rays originate on the fang. (C) PIXE image, showing the same region as B in manganese X-rays. Manganese appears to be concentrated on the tips of the marginal teeth. Scale bar, 100 μm.

Robert Schofield



Haunting Rag

Played by the
PDP-7, 1975

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1st track at - http://www.soemtron.org/downloads/decinfo/track03.mp3
2nd track at - http://www.soemtron.org/downloads/decinfo/track05.mp3